Date: August 20, 2004

Subject: Addendum to the Human Health Risk Assessment for the Diamond Lake Restoration Project—Alternative 5

To: Sherri Chambers, IDT leader

Introduction

The Umpqua National Forest, in cooperation with multiple state and federal agencies, proposes to use two formulations of the fish toxicant, rotenone, to eradicate unwanted tui chub fish in Diamond Lake. This action is proposed in order to improve both water quality and the trout fishery, which have been substantially diminished due to the tui chub population. The Draft EIS issued in March 2004 included two alternatives (Alternatives 2 and 3) that would apply both the liquid and powdered formulations of rotenone. Alternatives 2 and 3 are identical with respect to the application of rotenone. Under both Alternatives 2 and 3, the powdered formulation of rotenone, known by its brand name, Pro-Noxfish®, would be applied to Diamond Lake in September when water volume, temperature and chemistry reach conditions considered optimal for achieving a complete fish kill within the lake. Pro-Noxfish® would be administered according to label instructions to reach a target concentration of between 0.025 and 0.10 parts per million (once thoroughly mixed in the lake). For example, based on a predicted water volume of 48,000 acre-feet following the draw down of the lake, mean temperature and pH observed in Diamond Lake in September, and a treatment concentration of 0.10 ppm (the high end of the target concentration range), it is estimated that about 260,000 pounds of powdered Pro-Noxfish® would be needed to eradicate the tui chub population.

Also under Alternatives 2 and 3, the liquid rotenone formulation, known by its brand name, Noxfish®, would be applied to two fish-bearing streams that feed into Diamond Lake in September. This product would be applied to attain a target treatment concentration of about 0.1 ppm, once mixed in the stream. It would be applied at drip stations in Silent and Short Creeks located on the south end of the lake. Drip stations would be operated for approximately 17 days in these two creeks where approximately 375 gallons of Noxfish rotenone would be dispensed into the creeks within drawn down area of the lake.

This report addresses the risks to human health associated with a new alternative, Alternative 5, which differs from Alternatives 2 and 3 in its use of the two rotenone formulations. Alternative 5 was developed as a result of public comments received during the DEIS comment period. It was suggested by expert personnel of California Fish and Game, that to achieve more certainty for full tui chub eradication, liquid rotenone should be used in the shallow areas of the lake occupied by aquatic plants. The liquid formulation is more effectively mixed in such environments, because it disperses more quickly and thoroughly than powder and has a higher likelihood of killing all of the fish present at the time of application.

Alternative 5

Alternative 5 would treat Silent and Short Creeks exactly the same as Alternatives 2 and 3 by using the liquid formulation, Noxfish®, at a concentration of 0.1 ppm as described above for those alternatives. Under Alternative 5, liquid rotenone would also be applied within Diamond Lake itself. This differs from Alternatives 2 and 3 which would only apply the powdered formulation of rotenone, Pro-Noxfish®, to the lake. Under Alternative 5, liquid rotenone would be applied to the shallow lake waters less than approximately 20 feet in depth, targeted at the high end of the approved range, 0.1 ppm. Based on a predicted water volume of 13,300 acre feet following the drawdown, it its estimated that approximately 8,900 gallons of liquid rotenone would be used in the lake under Alternative 5. Powdered rotenone would be applied to lake waters greater than 20 feet in depth also at an active rotenone concentration of 0.1 ppm. Based on a predicted water volume of 31,000 acre feet following the drawdown, it its estimated that approximately 168,000 pounds of powdered rotenone would be used in the lake. Powdered rotenone is the recommended formulation for these areas because it would disperse adequately and it less expensive.

As with Alternaives 2 and 3, the timing of the applications under Alternative 5 would occur in September when water temperature and chemistry reached conditions considered optimal for achieving a complete fish kill. Rotenone would be administered according to label instructions at the necessary amounts based on water volume, temperature, and chemistry in Diamond Lake at the time of application. Alternative 5 would also employ the same strategy as applied with Alternatives 2 and 3 to determine the exact amount of rotenone of both formulations to apply. As such, prior to application, site-specific bioassay tests would be conducted on tui chub utilizing rotenone from the batch to be used in lake treatment and water from Diamond Lake.

The transportation and storage of the rotenone would be the same as that detailed for Alternatives 2 and 3, and the mitigation measures to protect human health would also be the same as those developed for Alternative 2 and 3. These are:

1. Rotenone would be stored at three operational sites: the north end dock facilities, Mt. Thielsen Campground and Broken Arrow Campground where security would be provided 24 hours/day at each site while rotenone is present on site. Rotenone would be stored in the delivery trucks. Enough potassium permanganate (rotenone neutralizer) to neutralize the largest container of rotenone would also be stored on site.

2. Certified pesticide applicators would be responsible for all phases of rotenone application.

3. The two outlets of the lake (Lake Creek and the reconstructed channel) would be closed and locked using control gates so treated water would not escape down the reconstructed canal or Lake Creek.

4. Diamond Lake would be closed to the public during the rotenone application period and only reopened when safety concerns were eliminated. Reopening

will be determined by continual monitoring of the assessment wells, the lake water, and the water in lower Lake Creek.

5. The summer home residents who use wells that tap the shallow aquifer (those than 100 feet deep) for domestic water would be notified in advance and required to use the supplied bottled water if rotenone or its other ingredients are detected in the monitoring wells. Monitoring of well water would occur to determine when well use could resume.

6. Bottled water will be supplied to all potentially impacted wells along the western shore of the Lake from Thielsen View Campground to Silent Creek should a detection of rotenone or other added ingredients be detected in any of the Forest Service monitoring wells along the west shore.

7. Diamond Lake outlets (Lake Creek and the reconstructed canal) would remain closed until tests indicated that rotenone, rotenolone[1], and all semi-volatile and volatile organic compounds associated with the chemical treatment had dissipated to non-detectable or trace levels in both the water column and lake bottom sediments (approximately one to two months).

8. The protective equipment listed on the labels of both rotenone formulations and potassium permanganate (should it be used to neutralize spills) would be used by all personnel who handle these products. This includes disposable coveralls, gloves, eye protection, face shields, nitrile gloves, and air purifying respirators. Extra amounts of cleansing water and all protective equipment and supplies will be on hand at all times during transport, storage, and application.

9. Community residences and businesses would be notified at least 72 hours prior to the application of rotenone.

10. Community residents would be informed about what they can do to minimize pesticide exposure.

11. A hot line, in cooperation with Douglas County Health Department, would be established to collect reports of any suspected pesticide-related illnesses potentially associated with the project.

12. The potassium permanganate (a rotenone neutralizer) would be kept away from any other oxidizing compounds and any flammable products such as gasoline, oil and alcohol.

13. All of the following detailed plans would be completed according to recommendations and examples provided in the "Rotenone Use in Fisheries Management: Administrative and Technical Guidelines Manual" (Finlayson et al. 2000) prior to project implementation:

    - rotenone application plan,

[1] Rotenolone is the metabolite (by product) of rotenone (Finlayson et al. 2000).

- site safety plan,
- site security plan, and
- spill contingency plan.

Hazard Analysis

The human health hazard analysis for Alternatives 2 and 3 (Fontaine and Obery, 2004) applies equally to Alternative 5. Though there would be proportionally more use of the liquid formulation of rotenone in Alternative 5 compared to Alternatives 2 and 3, the hazards would be the same as disclosed under Alternatives 2 and 3 of the original report. In summary, regardless of the formulation, liquid or powder, rotenone is extremely toxic in its undiluted states. Both formulations are reported to be potentially fatal in their undiluted states, if inhaled or ingested. Ingestion or inhalation of the undiluted substances can cause numbness, nausea, vomiting, and tremors. Both the undiluted rotenone formulations are highly toxic when inhaled and are considered more toxic when inhaled than when ingested.

Both rotenone formulations proposed for use in Alternatives 2, 3, and 5 are reported to be slightly toxic to non-irritating to the skin from dermal exposure. Dermal exposure to undiluted rotenone can cause skin and eye irritation. Once rotenone is diluted in water at the concentrations listed on the EPA-approved label, it is relatively benign.

Most rodent studies have revealed no evidence of carcinogenic activity and the prevailing scientific opinion is that rotenone is not carcinogenic (USEPA, 1981 and 1989).

Inert Ingredients, Metabolites, and other Chemicals

Chemical manufacturers often add other ingredients to their formulations, called inert ingredients, to enhance effectiveness. The powered formulation, Pro Noxfish® has no added inert ingredients; it is composed simply of the ground up plant material. The liquid Noxfish® that would be applied to Short and Silent Creeks, and the shallow portions of the Lake under Alternative 5 contains inert emulsifiers, solvents, and carriers that are important in ensuring the solubility and dispersion of this liquid formulation. Water treated with liquid Noxfish® was found to contain rotenolone (the metabolite of rotenone), and volatile organic compounds (trichloroethylene, xylene, toluene, and trimethylbenzene) and semi-volatile organic compounds (naphthalene, 1-methyl naphthalene, and 2-methyl naphthalene). These volatile and semi-volatile organic compounds naturally breakdown and dissipate in treated water before rotenone and rotenolone (Finlayson et al. 2000).

Five California rotenone projects were monitored for the fate of the compounds of powdered and liquid formulations including inerts in sediments (Finlayson et al, 2001). Only the naphthalene and methyl naphthalene (associated with the liquid Noxfish®) temporarily accumulated in sediments, but this was for a period of less than 8 weeks. The other inert compounds in Noxfish® did not persist in sediments.

Nine California rotenone projects were monitored for the inert ingredients in Noxfish® in surface water (Finlayson et al, 2001). All ingredients were well below the minimum concentrations allowed under maximum contaminant levels (MCLs) for these ingredients in drinking water standards set by the EPA (Finlayson, 2001). Of the seven organic compounds found in Noxfish, trichloroethylene (TCE) is the only carcinogen; the rest are considered noncarcinogens. However, there are inconsistencies in the scientific literature regarding whether naphthalene is carcinogenic. Naphthalene was reported in one source as causing carcinogenic activity in rat nose tissue in an inhalation study (US National Toxicology Program, 2001). The bulk of the toxicology literature however supports that naphthalene is not carcinogenic.

Following application of Noxfish, samples collected during application into flowing water did not detect TCE (<0.5 ug/L) or xylene (<0.5 ug/L) except for one sample collected immediately below a drip station at 0.76 ug/L TCE and 0.56 ug/L xylene. Naphthalene and 2-methylnapthalene were detected at concentrations ranges of <0.5 to 57 ug/L and <2 to 50 ug/L, respectively. Table 1 displays the available human health standards set by the EPA for rotenone and other associated chemicals.

Table 1. Human Health Standards, Risk-based Safe Levels, and Detection Limits for Drinking Water

Fish Toxicant Ingredients	Maximum Contaminant Level[1] (ug/L)	Maximum Contaminant Level Goal[1] (ug/L)	Preliminary Remediation Goal[2] (ug/L)	Analytical Detection Limit (ug/L)	Analytical Method
Rotenone	Not Available	Not Available	150	50	SDWA EPA Method 553 (HPLC)
Naphthalene	Not Available	Not Available	6.2	0.5	SWDA EPA Method 524.5
Toluene	1,000	1,000	720	0.5	SWDA EPA Method 524.5
Trichloroethylene	5	Zero	0.028	0.006[3]	USEPA 8260 Mod SIM
Trimethylbenzene	Not Available	Not Available	Not Available	0.5	SWDA EPA Method 524.5
Xylene	10,000	10,000	210	0.1	USEPA 8260 Mod SIM

NOTES:
1 USEPA 2002b Based on safe drinking water standards.
2 USEPA 2002a Based on safe risk-based levels for residential tap water use.

3 Value provided is the MDL instead of the reporting limit. The reporting limit for TCE is 0.05 ug/L using EPA Method 8260 Mod GCMS-SIM.

MCL – maximum contaminate level. The highest level of a chemical allowed in drinking water. It is an enforceable level under the Safe Drinking Water Act.
PRG - preliminary remedial goal. The level of a chemical in drinking water that is not expected to cause any adverse effects for a lifetime of exposure. Lifetime exposure is based on 30 years of exposure for a child and adult drinking 1 and 2 liters, respectively.
Analytical Detection Limit. The level at which a chemical can be accurately and precisely quantified by a certain method.
SWDA – Safe Drinking Water Act. Gives EPA the authority to set drinking water standards. Used in the context of analytical methods developed under the SWDA program for monitoring water quality.
RCRA Resource Conservation and Recovery Act. Used in the context of analytical methods developed under the RCRA program for monitoring water quality.

The possible metabolites of rotenone are carbon dioxide and a more water soluble compound (rotenolone) that is excreted in the urine. Studies indicate that approximately 20 percent of applied oral doses are eliminated from the animals system within 24 hours.

Potassium permanganate is an oxidizer that would be used with this project to neutralize the rotenone formulations in the event of a spill. It has no deleterious effects at the concentrations normally associated with the neutralizing process (Finlayson et al, 2000). However in its concentrated form, it is caustic to mucous membranes in the nose and throat. The required protective clothing and breathing apparatus when handling the concentrated powder would lessen human health risks.

2. Exposure Analysis

The exposure analysis for Alternative 5 is no different from that of Alternatives 2 and 3. No public exposure is expected, regardless of the type of rotenone used or the concentration of rotenone applied (within the concentration ranges approved by the EPA). Even though diluted rotenone poses no threat to swimmers and bathers, the lake would never the less be closed to the public until all detectable levels of rotenone and inert ingredients have broken down. No member of the public would have access to the dangerous undiluted formulations due to tight security measures. No public exposure to contaminated fish is expected because fish will rapidly sink, many carcasses will be removed from the area, and warning signs will be posted. The ground water will be monitored to determine if the shallow, domestic wells become contaminated, and in that event, such residents would be required to only use bottled water, which would be supplied. No use of tainted well water would be allowed until monitoring shows that all traces of rotenone and the inert ingredients have broken down. No rotenone would escape downstream because the lake would be in a drawn down state with no outflow out of Lake Creek. A ground water seepage study revealed little to no risk of groundwater seepage within the first 6 miles of Lake Creek, so downstream exposure routes are not expected.

The potential exposure to the undiluted formulations is the same for Alternative 5 is it is for Alternatives 2 and 3. Both formulations are very dangerous if inhaled or ingested to application workers and the mitigation measure developed for Alternatives 2 and 3 would also apply to Alternative 5:

- A 24 hours/day security effort where the rotenone is stored.
- Enough potassium permanganate (rotenone neutralizer) would be on-hand to neutralize the largest container of rotenone stored on site.
- Certified pesticide applicators would be responsible for all phases of rotenone application.
- The protective equipment listed on the labels of both rotenone formulations will be used by all personnel who handle these products. This includes disposable coveralls, gloves, eye protection, nitrile gloves, and air purifying respirators. Air purifying respirators provide a 10 to 50 fold protection factor. Extra replacements will be available at all times during the implementation phase.
- All of the following detailed plans would be completed according to recommendations and examples provided in the "Rotenone Use in Fisheries Management: Administrative and Technical Guidelines Manual" (Finlayson et al. 2000) prior to project implementation: rotenone application plan, site safety plan, site security plan, and a spill contingency plan.

These measures, and strict adherence to EPA-approved label directions for each formulation, would lessen risks to application workers regardless of the formulation used and the ultimate concentration within the approved range.

3. Risk Analysis

The risk analysis is an assessment of whether the potential exposure pathways (described in the above exposure analysis) would lead to any actual toxic effects as described in the hazard analysis, when compared to the existing guidelines set for rotenone by the US Environmental Protection Agency.

The risk analysis for Alternative 5 for the general public is no different that that found for Alternatives 1 and 2. Regardless of the type of formulation and the ultimate concentration which would be applied within the acceptable range following label directions, Alternative 5 would result in no more risk to human health than Alternatives 2 and 3. This is because there is essentially no chance of exposure to members of the public. What little chance exists, is through ground water contamination of shallow domestic wells. Yet the highest concentration of mixed rotenone that might seep into such wells (the target concentration of Alternative 5 (0.1 mg/L or ppm), is still less than the PGR safe level of 0.15 mg/L or ppm. The safe level is protective of children and adults drinking 1 and 2 liters of water per day, respectively, for 350 days per year for 30 years.

Risks from inert ingredients in the diluted liquid formulation are considered to be very low given the fact that the inerts typically break down faster than the rotenone. Thus the mitigation measures incorporated into Alternative 5 such as lake closure, public warnings, and required use of bottled water in the event of well contamination, would lessen risk of human health associated impacts associated with the inert ingredients of the liquid rotenone. Based on the monitoring of surface waters in nine California

rotenone projects were liquid Noxfish® was applied, the inert ingredients were well below the minimum concentrations allowed under maximum contaminant levels (MCLs) for these compounds set by the EPA (Finlayson et al, 2001).

Based on the above analysis, it is clear that the risks to human health under Alternative 5 are essentially the same as those disclosed for Alternatives 2 and 3. The disclosure of direct, indirect and cumulative effects for the original human health report (Fontaine and Obery, 2004) applies also to Alternative 5.

Prepared By:

BARBARA FONTAINE **DATE**

US Forest Service
Fish and Wildlife Biologist
North Umpqua Ranger District
Glide, Oregon Barbara Fontaine